

Arbuscular Mycorrhizal Fungi do not Enhance Nitrogen Uptake in Pinot noir When Phosphorus Supply is Adequate

R. Paul Schreiner & Tian Tian, USDA-ARS-HCRU, Corvallis OR & Oregon State University, Corvallis, OR

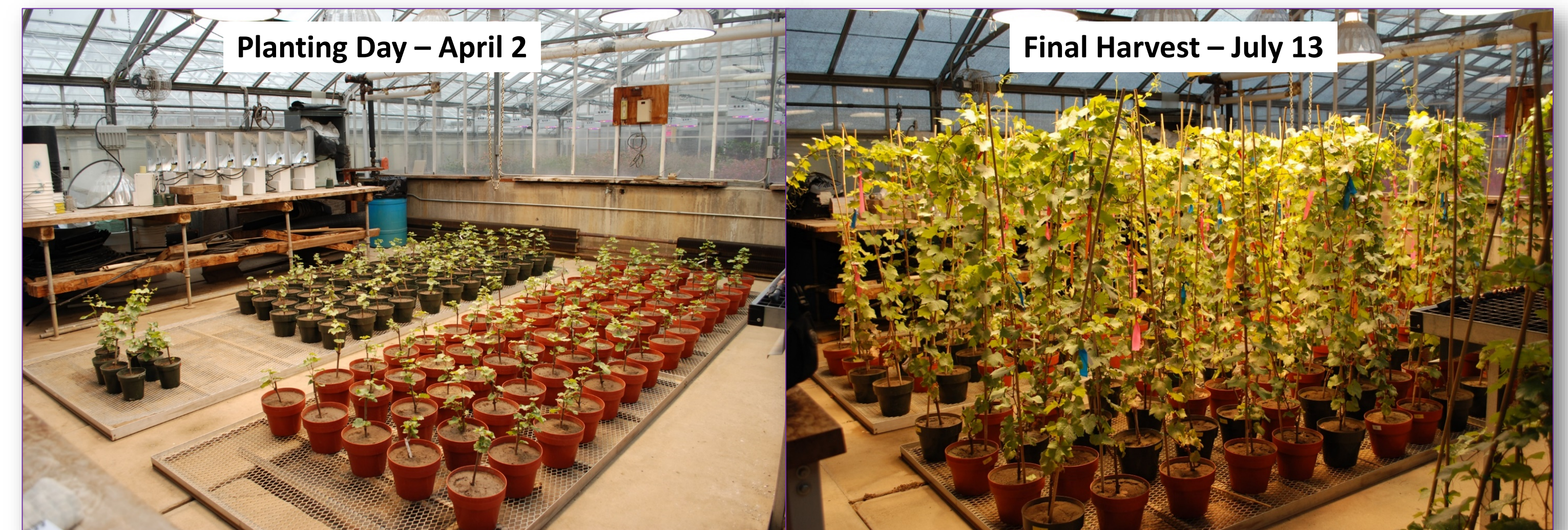
ABSTRACT: Grapevines form associations with arbuscular mycorrhizal fungi (AMF) that enhance nutrient uptake, especially phosphorus (P). Studies in other crops indicate that AMF can increase plant nitrogen (N) acquisition, but whether AMF improve N uptake in grapevines is unclear. To understand if AMF play a role in N uptake, responses of mycorrhizal and non-mycorrhizal Pinot noir grapevines were compared using a range of N and P inputs in the greenhouse. A soil with moderate P was used to ensure vines were not P-deficient, which masks the ability to test if AMF increase N uptake. A factorial experiment with four rates of N (0, 3, 6, or 12 mM N as ammonium nitrate), three rates of P (0, 1, or 2 mM P as potassium phosphate), and two AMF treatments (mycorrhizal, non-mycorrhizal) was conducted using potted vines. Shoot growth and mycorrhizal colonization of roots were periodically assessed, and vines were destructively harvested to determine biomass and nutrient uptake after exposure to different N and P treatments for nine weeks. Shoot and root biomass increased with increasing N supply, but shoot length and dry weight were both suppressed by AMF at intermediate levels of N. Phosphorus supply did not alter vine biomass. Vine N uptake increased with N supply, but N uptake was not improved by AMF at any level of N or P supply. Across all treatments, AMF enhanced the uptake of P and zinc. Root colonization by AMF was reduced at the lowest rate of N supply, while arbuscules in roots were higher at intermediate rates of N coincident with reduced shoot growth. These findings indicate that AMF do not enhance N uptake when vines receive inorganic N, and that AMF may compete with shoots for carbon when N supply is moderate and P is ample for growth.

Hypotheses Tested:

- 1) AMF enhance vine N uptake when soil N and vine N status is low; and the contribution of AMF to N uptake decreases as N supply increases
- 2) Increasing N supply decreases mycorrhizal colonization in roots, and this inhibition is greater as P supply increases

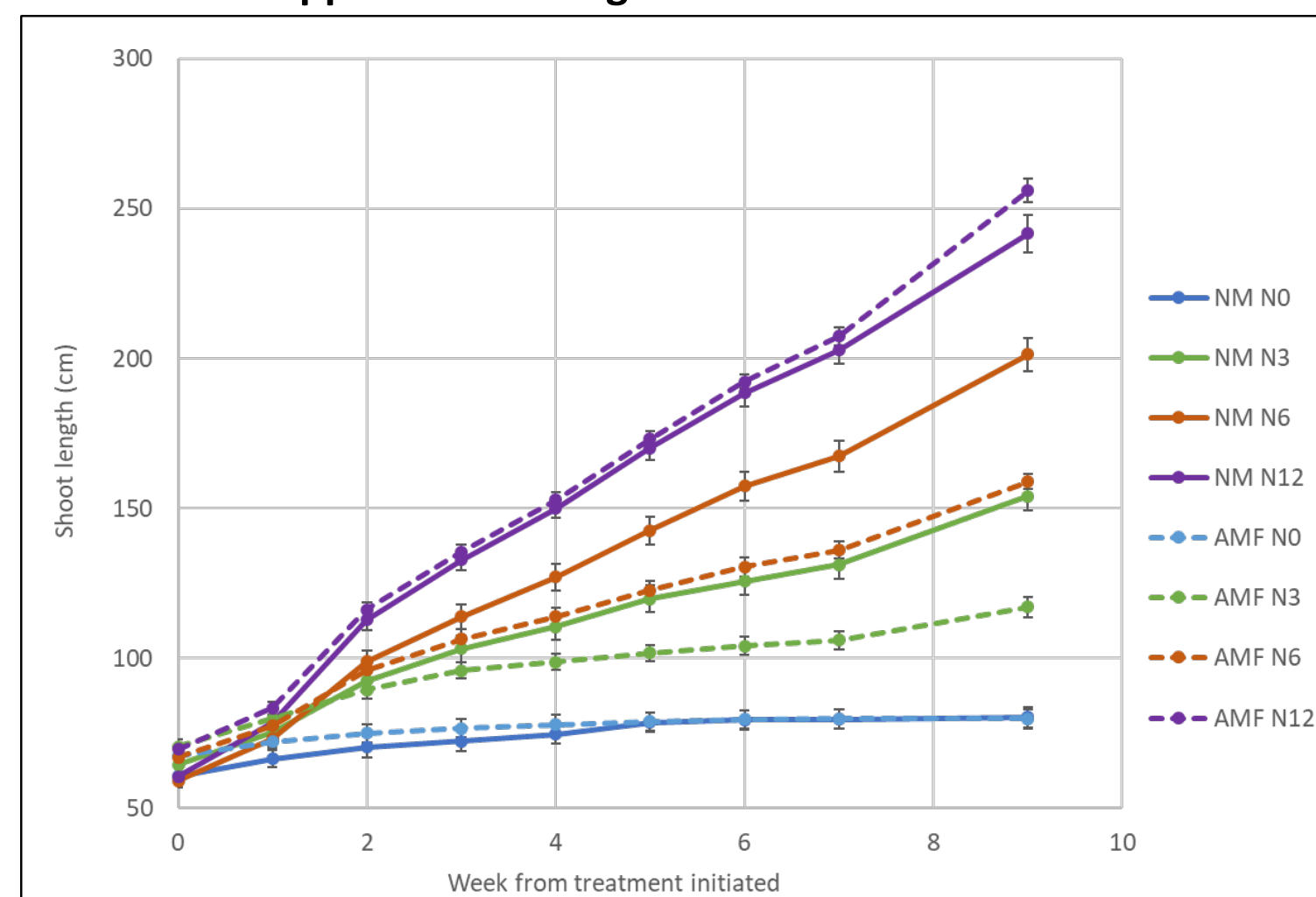
Methods:

- 1) Pre-rooted cuttings of Pinot noir were planted into pasteurized soil with a moderate level of phosphorus and inoculated or not with mycorrhizal fungi.
- 2) Vines were grown for 6 weeks with medium fertilizer (6 mM N), and then treated with 4 rates of N (0, 3, 6, 12 mM) and 3 rates of P (0, 1, 2 mM) and grown for another 9 weeks.
- 3) Vines were destructively harvested to determine biomass, nutrient concentrations, and nutrient contents for all tissues.

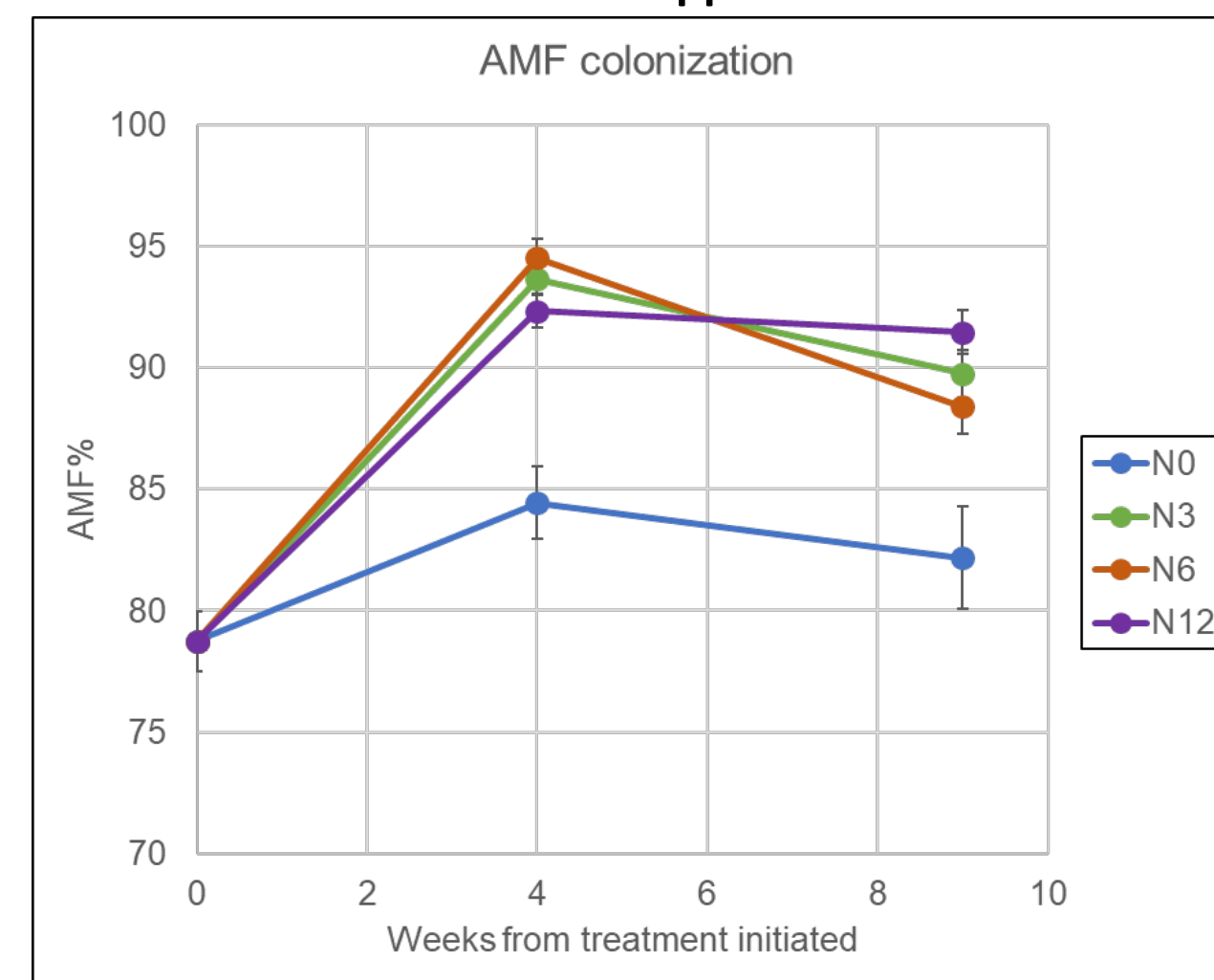


Results:

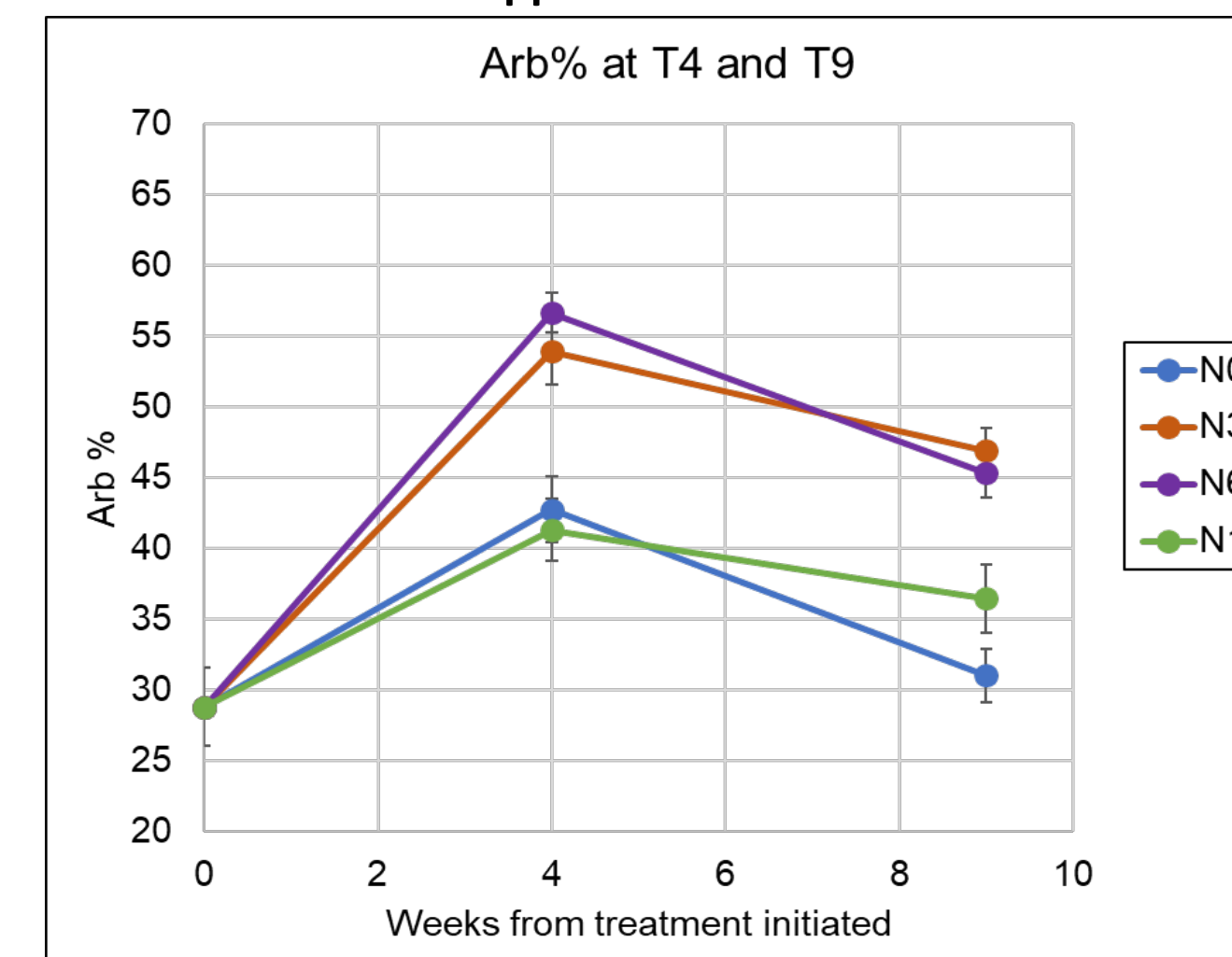
AMF suppressed shoot growth in the N3 & N6 treatments



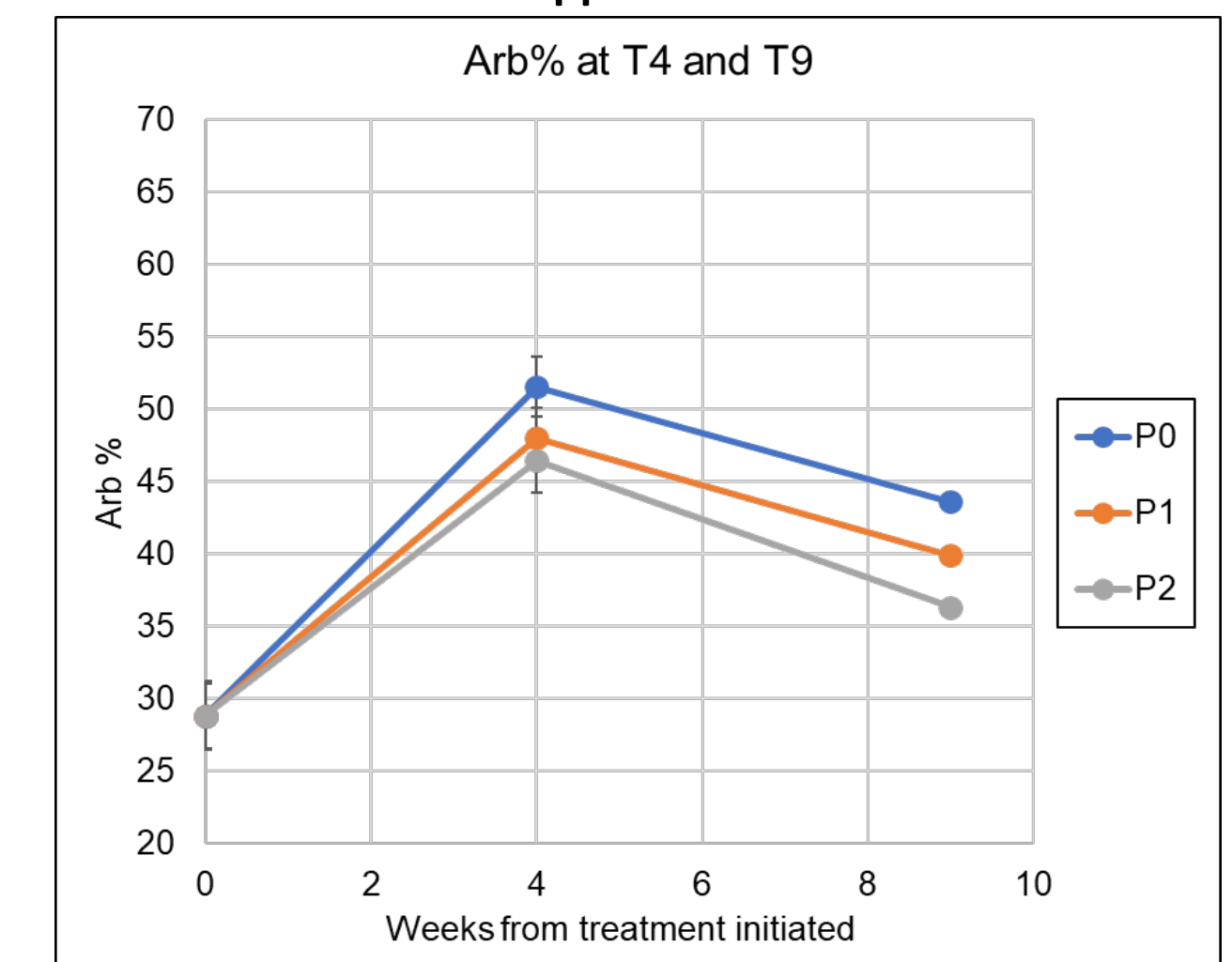
AMF root colonization was suppressed in N0 treatment



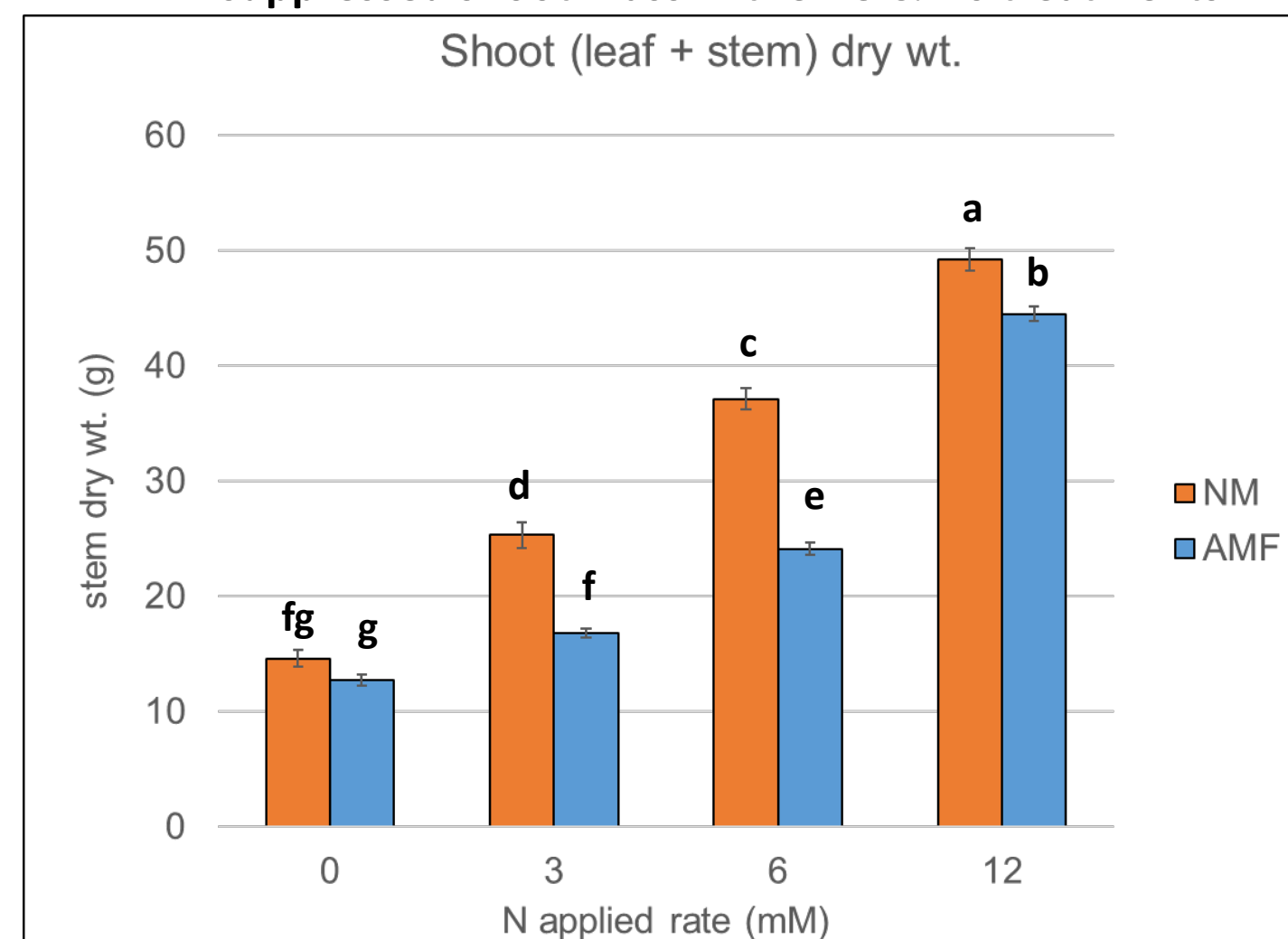
Arbuscules were suppressed in N0 & N12 treatments



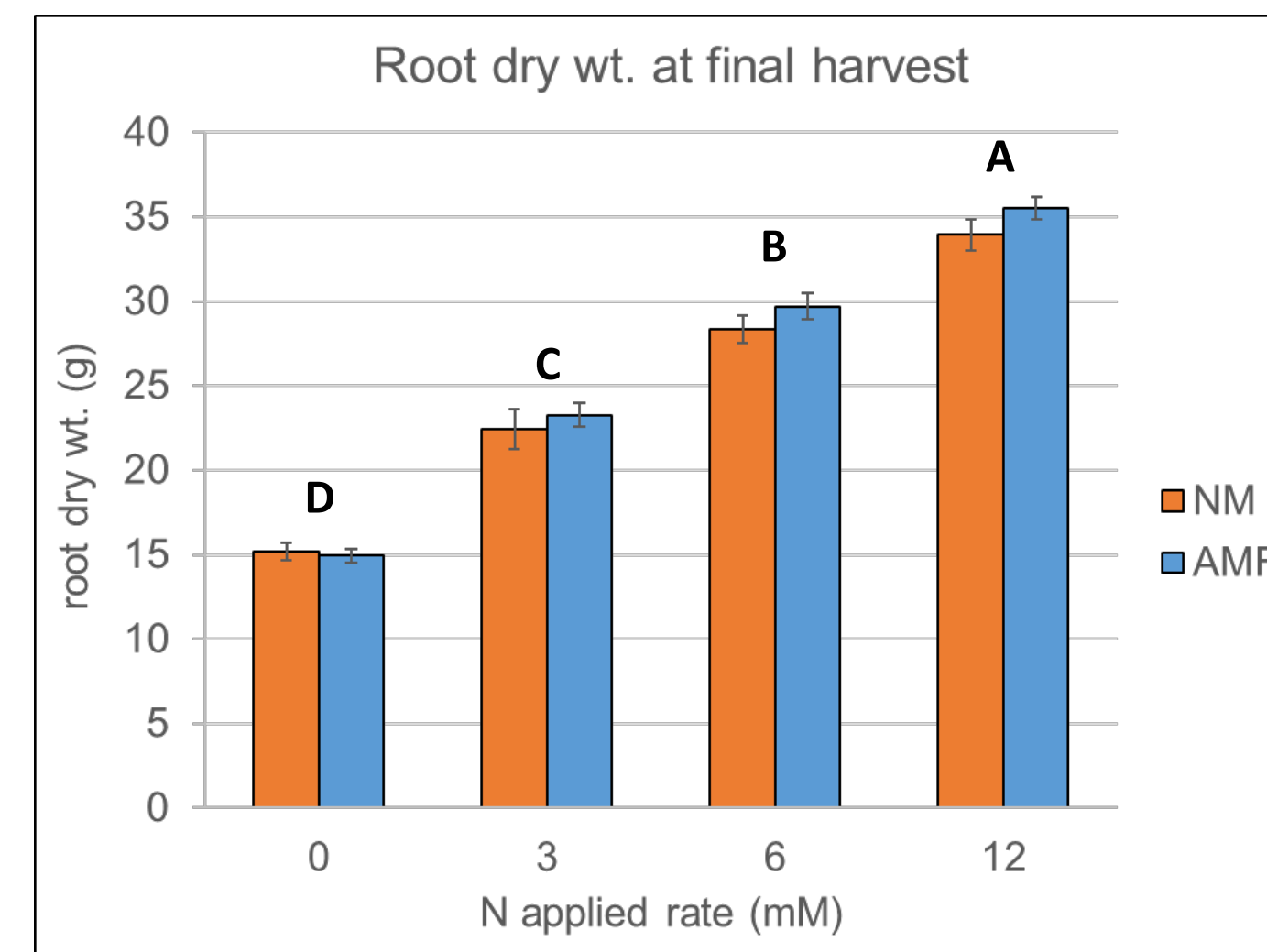
Arbuscules were suppressed in P2 treatment



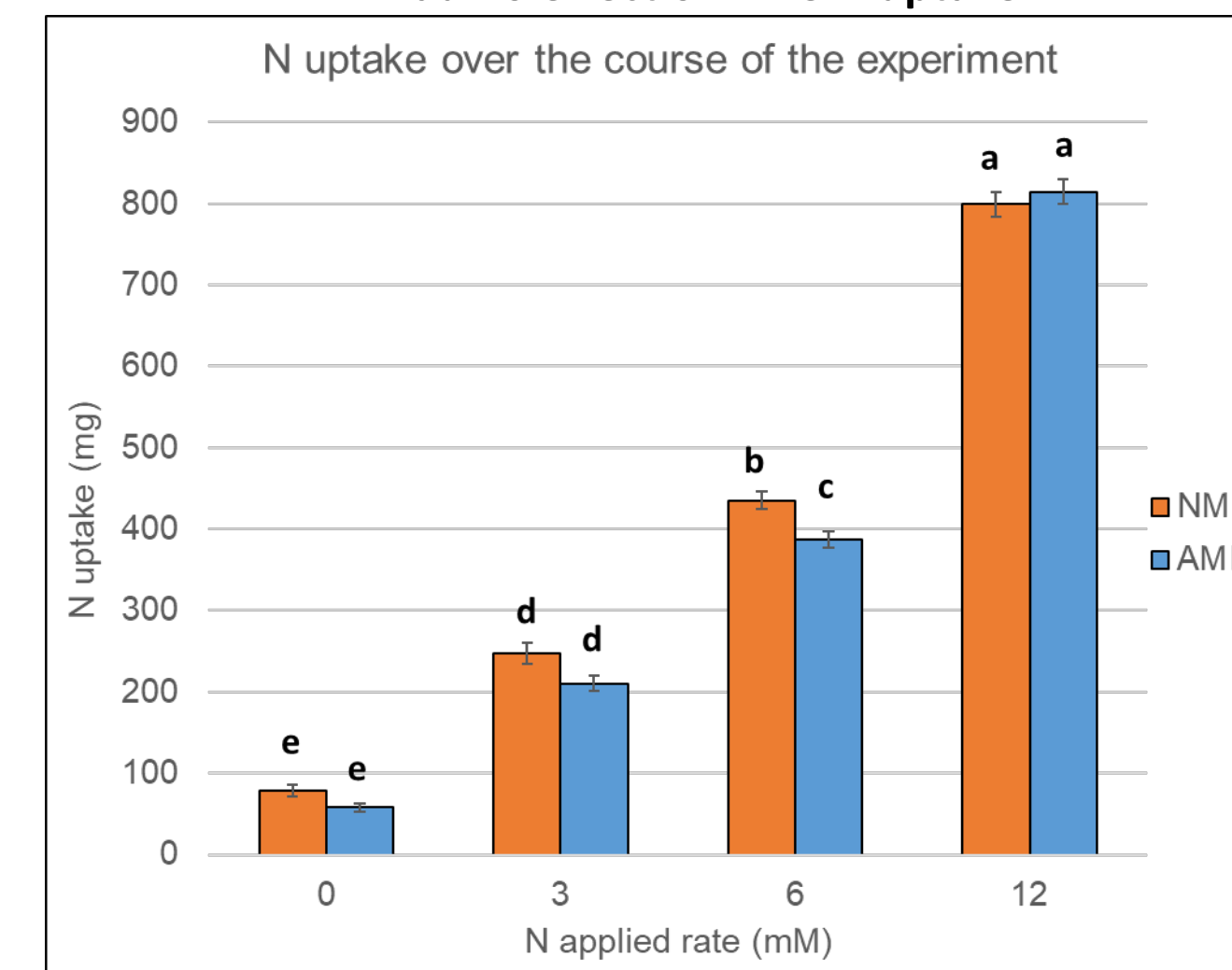
AMF suppressed shoot mass in the N3 & N6 treatments



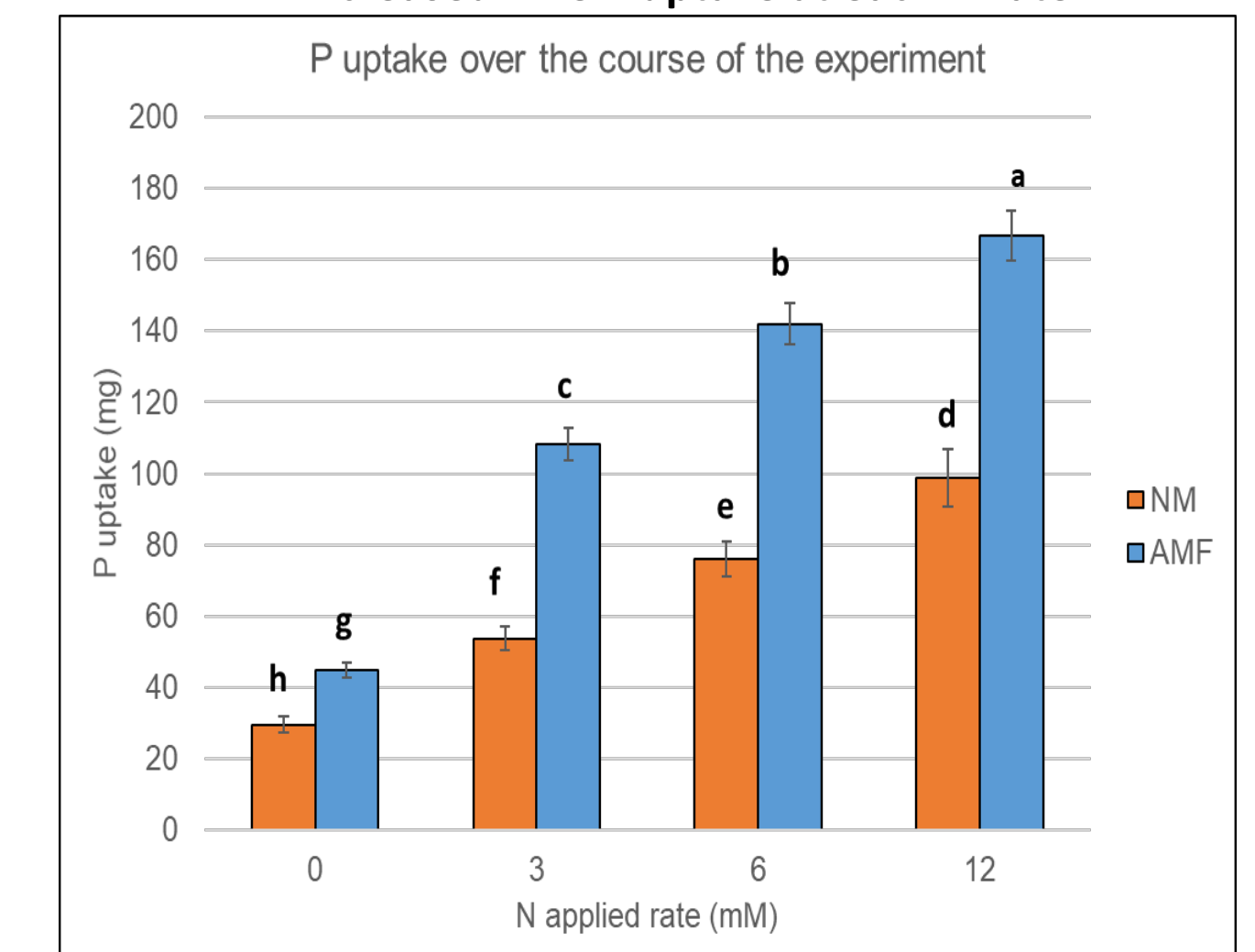
AMF had no effect on root mass



AMF had no effect on vine N uptake



AMF increased vine P uptake at each N rate



CONCLUSIONS: 1) **Hypothesis #1 is rejected:** AMF did not enhance N uptake in any case examined here (indeed, N uptake was reduced at N6); 2) **Hypothesis #2 is predominantly rejected:** Arbuscules in roots were decreased at the highest N rate, but also at the lowest N rate. Arbuscules were also decreased at the highest P rate, but only as a main effect (no interaction between N and P rates); 3) **AMF root colonization may have been limited by N at N0;** 4) **Greater arbuscules and greater P uptake decreased shoot growth only at intermediate N supply.**